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ABSTRACT

This report compares the Oregon Mathematics Comprehension Curriculum Goals (CCG) with the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics. After discussing the philosophical positions of the two documents, three sections comparing the two by level are presented. Each standard from the NCTM Standards document and the related content strands of the CCG are listed by number; a rating is provided to indicate how the Oregon goals match the NCTM Standards. This report concludes that the two documents are very similar in philosophy and that they both make a strong case for learning mathematics actively through "doing" mathematics. Topics of the Oregon goals that need to be strengthened are identified. (YP)

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Correlation Paper

on

The Oregon Mathematics Comprehensive Curriculum Goals

and

The National Council of Teachers of Mathematics Curriculum and Evaluation Standards for School Mathematics

Division of Curriculum and School Improvement

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INTRODUCTION

Oregon's updated mathematics curriculum, developed over the last five years, will be impacted by the recently published recommendations for national mathematics reform.

This document outlines the match between the Oregon Mathematics Comprehensive Curriculum Goals (CCG) and the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (Standards). The document comes about at the request of many interested mathematics educators and curriculum specialists who are asking how the Oregon CCG match with the National Standards. Since the Standards have received a great deal of exposure in the national media, it seemed only natural that Oregon educators would be concerned about how the document used in Oregon school districts matches what the very influential NCTM is promoting as the direction for mathematics education through the beginning of the 21st Century.

History of the Two Documents

The CCG document is an outgrowth of efforts to bring some consistency to the expectations for students within Oregon schools. The Essential Learning Skills were developed to identify the knowledge and skills that are to be taught and applied in every subject area. These were followed by the Common Curriculum Goals for mathematics that list the expectations for students to attain by the end of grades 3, 5, 8, and 11. Finally, the Comprehensive Curriculum Goals were developed to identify the expectations for students in grades K-8 and 11. By design the CCG reflects a six-year plan that coincides with the Oregon textbook adoption cycle. The current CCG document was started in 1984 with publication in 1987. The CCG represents a very practical, forward-looking approach to mathematics education without trying to be a far-reaching, long-range document. Just before the writing of the Essential Learning Skills, the Oregon Mathematics education community developed a series of mathematics concept papers. These papers became important references for the writers of the CCG and were also used by the writing groups of the Standards document.

The Standards document grew out of a reaction to all the "calls to excellence" that were written by many different groups. The document was first drafted in the summer of 1987, just before the CCG was published. The Standards reflect the best thinking of several groups of mathematics educators looking into the future and projecting what an effective, viable mathematics curriculum should be. Besides content and instructional practices, the Standards document also contains suggestions on what the evaluation component associated with mathematics should look like. Please note that this correlation document does not address the evaluation standards. Unlike the CCG, the Standards do not have a timeline. They were written to truly look into the future -- perhaps even into the beginning of the 21st Century. The Standards document is a philosophical statement of what mathematics education ought to be.

Philosophical Positions

Both the CCG and Standards documents offer sections of philosophical positions. The CCG contains two philosophical sections: Instructional Themes, and Organizational Patterns and Teaching Considerations. Included are positions on the following topics: problem solving, cooperative learning, thinking and doing mathematics, calculators and computers, role of the textbook, and teaching considerations. These topics offer a vision of what a

mathematics classroom can be. The philosophical position of the Standards document is woven throughout the document and is found in sections on basic assumptions, societal goals, student goals, teacher goals, and lists of curriculum topics and instructional strategies which should receive increased or decreased attention. The philosophies in the two documents match very well.

In philosophy and mathematical goals, both documents go beyond what is normally found in a textbook program. Both go far beyond a paper-pencil worksheet course. Both see students actively engaged in mathematical thinking. Both see mathematics tied to the real world of the student in solving everyday problems. Both see the power of technology being used as a tool to aid in problem solving.

Format of Analysis Paper

The Correlation Paper follows the format found in the Standards document. It presents three sections separated by level: K-4, 5-8, and 9-12. First, each standard is presented in italics as a direct quote from the Standards document. Next, the related content strands of the CCG are listed by number and rated in a statement of how the goals match with the standards. One of these four ratings is used: poor (*), fair (**), good (***), and excellent (****). The ratings were derived from the number of times the writing team matched a goal to a particular standard. Following the ratings are one or more short paragraphs citing evidence for the rating.

The writing team recognizes areas of improvement to be made. Perhaps this will happen during the revision of the CCG prior to the next textbook adoption. Calculators and computers must become a more evident part of mathematics education. Mathematics education needs to include the power in these instruments. From the basic four-function calculator, to the graphing calculator, to the computer, students need to see these instruments as tools to help their study of mathematics. Connections within mathematics and between mathematics and other disciplines need to be strengthened. The Essential Learning Skills will help in attempting to improve the connections between subject areas. The current goals will help with these connections between the concrete learning of a concept and the abstract algorithm that follows. The next CCG revision will need to guide linkage of these connections between topics within mathematics.

The writing team found a great deal of match between the two documents. This confirms the notion that Oregon's mathematics education community is on the leading edge of developments in the mathematics education field. In conclusion, the CCG and Standards documents can serve as guides for districts interested in curriculum revision within the next few years.

A table of contents in the form of a summary of standards' topics plus the rating of the related content strands of the goals is provided on page 3. Each rating is analyzed and discussed on the page(s) listed in the far right hand column. Where applicable, the standards' topics are placed to read across levels (columns) to indicate when a topic is developed at each of the grade levels, e.g., Standards 1, 2, 3 and 4 carry across all three grade levels so these are rated at each level (column) and analyzed on each of the 3 consecutive pages listed in the right hand column. In cases where the topics are slightly different in perspective, the ratings are indicated beside the more specific title and the pages for analysis are referenced in both places. For comparison, the grade level topics and ratings are outlined into grade-level groups like overlay pages for quick reference.

CORRELATION SUMMARY OF RATINGS ON COMPREHENSIVE CURRICULUM GOALS and STANDARDS

* Poor ** Fair *** Good **** Excellent

LEVEL/#	STANDARD	RATING: K-4	5-8	9-12	CCG Ref.(see NOTE)	Analyzed on Page(s)
K-4	1. Problem Solving	****	(1) ****	(1) ****	3.0	4, 12, 21
	2. Communication	****	(2) ****	(2) ****	8.0	4, 12, 22
	3. Reasoning	****	(3) ****	(3) ***	6.0, 7.0 & all Strands	5, 13, 23
	4. Connections	**	(4) *	(4) ***	2.0, 7.0 & all Strands	5, 14, 23
	5. Estimation	***	see 7		1.0, 2.0, 4.0, 5.0	6, 15
	6. Numeration	****	see 5		1.0	6, 14
	7. Concepts - Whole Number	***			2.0	7, 15
	8. Computation - " "	****	see 7		2.0	8, 15
	9. Geometry - Spatial	**	see 12	see 7 & 8	4.0	8, 19, 25
	10. Measurement	****	(13) ****		5.0	9, 19
	11. Statistics & Probability	****	see 10 & 11	see 10 & 11	6.0	9, 17, 27
	12. Fractions & Decimals	***			1.0 & 2.0	10, 14
	13. Patterns & Relationships	****			All strands	10, 16
5-8	5. Number & Relationships		***		1.0, 2.0, 7.0 & across strands	14
	6. Number Systems & Theory		***		1.0 & 7.0	15
	7. Computation & Estimation		****		2.0 + 5.0 & 6.0	15
	8. Patterns & Functions		****		6.0 & 7.0 also 1.0, 3.0, & 4.0	16, 24
	9. Algebra		**	(5) *	3.0, 4.0, 6.0, 7.0	17, 24
	10. Statistics (See 11 above)		****	(10) ***	6.0	17, 27
	11. Probability..."..." "		**	(11) *	6.0	18, 27
	12. Geometry (also 9 above)		****	see 7 & 8	4.0	19, 25
	13. Measurement (See 10 in K-4)					19
9-12	5. Algebra (See 9 in 5-8)					24
	6. Functions			*	7.0	24
	7. Geometry - Synthetic (See 12 above)			***	4.0	25
	8. Geometry - Algebraic " " "			*	none	26
	9. Trigonometry			*	none	26
	10. & 11. Prob. & Stat. (See 10 & 11 in 5-8)					17, 27
	12. Discrete Mathematics			*	none	28
	13. Conceptual Calculus			*	none	29
	14. Mathematical Structure			*	none	29
	Summary Statement					30

NOTE: CCG number 9, Study Skills, is not addressed in the Standards.

STANDARD 1: MATHEMATICS AS PROBLEM SOLVING

In grades K-4, the study of mathematics should emphasize problem solving so that students can:

- *use problem-solving approaches to investigate and understand mathematical content;*
- *formulate problems from everyday and mathematical situations;*
- *develop and apply strategies to solve a wide variety of problems;*
- *verify and interpret results with respect to the original problem;*
- *acquire confidence in using mathematics meaningfully.*

CCG Strand 3.0 (and throughout all strands)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and NCTM Standards for this standard is excellent. ****

A strong emphasis on problem solving is evident in the matching goal. The Oregon document addresses problem solving and cooperative learning extensively in narrative form both within the instructional themes, as well as within student goals. These themes and goals match the philosophy of the Standards document.

Students are asked to use real-world problems, applications and strategies to formulate and solve meaningful problems throughout all content strands.

Although not directly stated as in Standard 1, "verify and interpret results with respect to the original problem," the CCG states that students will verify by checking reasonableness of answers, find relationships in numbers and problems, and interpret and produce data and graphs. These goals are found throughout the strands in addition to the goal in the Problem-solving Strand.

STANDARD 2: MATHEMATICS AS COMMUNICATION

In grades K-4, the study of mathematics should include numerous opportunities for communication so that students can:

- *relate physical materials, pictures, and diagrams to mathematical ideas;*
- *reflect upon and clarify their thinking about mathematical ideas and situations;*
- *relate their everyday language to mathematical language and symbols;*
- *realize that representing, discussing, listening, writing, and reading mathematics are a vital part of learning and using mathematics.*

CCG Strand 8.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

The communication strand, included in the CCG, is a powerful step toward integration in curriculum. Oregon emphasizes teaching the use of language arts and study skills in every mathematics classroom.

Teachers are asked to show the interrelationship of everyday language to the symbolic language of mathematics and to provide opportunities for oral and written communication which deal with mathematical concepts and problem solving in their classrooms.

One of the instructional themes within the CCG addresses the use of cooperative learning strategies which naturally stimulate oral communication.

STANDARD 3: MATHEMATICS AS REASONING

In grades K-4, the study of mathematics should emphasize reasoning so that students can:

- *draw logical conclusions about mathematics;*
- *use models, known facts, properties, and relationships to explain their thinking;*
- *justify their answers and solution processes;*
- *use patterns and relationships to analyze mathematical situations;*
- *believe that mathematics makes sense.*

CCG Strand 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

The CCG does not contain a separate strand for reasoning but this strand can be found within the strand called Mathematical Relationships. The student activities in the Standards document align nicely with the goals in the Mathematical Relationships Strand.

The CCG has students reflect, describe and act upon their reasoning and the reasoning of others. They are to build, model, find patterns and organize information to support their reasoning, as well as draw logical conclusions from information acquired.

Students should "believe that mathematics makes sense" based upon increased emphasis on real problems, applications and a knowledge base built through experiences from concrete to abstract activities.

STANDARD 4: MATHEMATICAL CONNECTIONS

In grades K-4, the study of mathematics should include opportunities to make connections so that students can:

- *link conceptual and procedural knowledge;*
- *relate various representations of concepts or procedures to one another;*
- *recognize relationships among different topics in mathematics;*
- *use mathematics in other curriculum areas;*
- *use mathematics in their daily lives.*

CCG Strand 2.0 and 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is <u>fair</u>. **

The CCG appears to have isolated strands without much connection between the strands or within mathematics instruction. The connections are not directly stated but do exist to some degree. The Computation Strand links computation to measurement. The CCG stresses use of models, such as money, when working with decimals. The Mathematical Relationships Strand comes closest to connecting several topics of mathematics instruction. Each of the strands is represented by goals in this strand. These connections, however, are hard to find throughout the document and need to be specifically stated.

The integration of mathematics into other curriculum areas is not addressed in the CCG. This integration of curriculum is documented in the Essential Learning Skills in which Oregon provides a link across all disciplines. Within the CCG document, the link between language arts and mathematics is explicitly dictated.

Addition of this standard should be considered when the CCG is revised.

STANDARD 5: ESTIMATION

In grades K-4, the curriculum should include estimation so students can:

- ***explore estimation strategies;***
- ***recognize when an estimate is appropriate;***
- ***use estimation to determine reasonableness of results;***
- ***apply estimation in working with quantities, measurement, computation, and problem solving.***

CCG Strand 1.0, 2.0, 4.0, and 5.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is <u>good</u>. ***

Estimation is not a separate strand in the CCG but rather a theme that is found throughout the appropriate content strands notably in, Number and Numeration, Computation, Measurement and Geometry.

The CCG asks students to use estimation strategies to sense reasonableness of answers. Rounding off numbers is the only strategy explicitly stated. The CCG refers to "other techniques" which need to be explicitly stated, such as looking at the leading digit or estimating with compatible numbers.

STANDARD 6: NUMBER SENSE AND NUMERATION

In grades K-4, the mathematics curriculum should include whole number concepts and skills so that students can:

- *construct number meanings through real-world experiences and the use of physical materials;*
- *understand our numeration system by relating counting, grouping, and place-value concepts;*
- *develop number sense;*
- *interpret the multiple uses of numbers encountered in the real world.*

CCG Strand 1.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

The CCG strand is consistent with the standard. Both documents say that the concept of number should be approached from a hands-on, "doing" model using concrete objects or pictorial representation within real-world experiences. All numeration concepts are well covered in the CCG.

STANDARD 7: CONCEPTS OF WHOLE NUMBER OPERATIONS

In grades K-4, the mathematics curriculum should include concepts of addition, subtraction, multiplication and division of whole numbers so that students can:

- *develop meaning for the operations by modeling and discussing a rich variety of problem situations;*
- *relate the mathematical language and symbolism of operations to problem situations and informal language;*
- *recognize that a wide variety of problem structures can be represented by a single operation;*
- *develop operation sense.*

CCG Strand 2.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

The CCG combines the Operations and Computation Standards into one strand titled Appropriate Computational Skills. Taken together the CCG has a better than adequate match, but with the two standards separated, the match for operations is just good.

The predominate CCG themes, such as real-world problems, use of language related to symbols, and modeling with concrete objects, are also present in this standard.

The standard specifically states, "recognize that a wide variety of problem structures can be represented by a single operation." This idea is only implied within the CCG. The next revision of CCG should include this part of the standard.

STANDARD 8: WHOLE NUMBER COMPUTATION

In grades K-4, the mathematics curriculum should develop whole number computation so that students can:

- *model, explain, and develop reasonable proficiency with basic facts and algorithms;*
- *use a variety of mental computation and estimation techniques;*
- *use calculators in appropriate computational situations;*
- *select and use computation techniques appropriate to specific problem situations and determine whether the result is reasonable.*

CCG Strand 2.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

There are many notable connections between these two documents. Throughout both documents, the themes of using concrete materials, estimation and everyday problems are common. They advocate proficiency with basic facts and choice of an appropriate tool for computation, such as calculator, mental, or paper/pencil. Both documents consistently emphasize that students should be taught to recognize when approximate rather than precise answers may be useful, as well as to check for reasonableness of answers. Both documents concur in stressing that computation should no longer be taught as merely a paper/pencil task.

STANDARD 9: GEOMETRY AND SPATIAL SENSE

In grades K-4, the mathematics curriculum should include two- and three-dimensional geometry so that students can:

- *describe, model, draw, and classify shapes;*
- *investigate and predict results of combining, subdividing, and changing shapes;*
- *develop spatial sense;*
- *relate geometric ideas to number and measurement ideas;*
- *recognize and appreciate geometry in their world.*

CCG Strand 4.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is fair. **

Both the CCG and the Standards emphasize an active approach to geometry. Both documents ask students to draw, model, construct, extend and manipulate objects to gain a better perception of geometric relationships. Both are consistent in emphasizing an appreciation of geometry in the environment.

The investigation phase in this standard extends beyond the requirements presented in the CCG when students are asked to "predict the results of combining and subdividing shapes." Another part of this standard that is not found in the CCG is connections between "geometric ideas" and "number and measurement ideas." This linkage should be included.

STANDARD 10: MEASUREMENT

In grades K-4, the mathematics curriculum should include measurement so that students can:

- *understand the attributes of length, capacity, weight, area, volume, time, temperature, and angle;*
- *develop the process of measuring and concepts related to units of measurement;*
- *make and use estimates of measurement;*
- *make and use measurements in problem and everyday situations.*

CCG Strand 5.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents contain comparable goals for measurement. Emphasis is placed on actively using measurement and estimation practices to develop measurement concepts.

In addition, the CCG expects students to understand, select and use the most appropriate instrument or unit for the measurement task.

A problem-solving approach using everyday situations is stressed in the measurement standard. This is consistent with the philosophy stated in the CCG for using real-world problems.

STANDARD 11: STATISTICS AND PROBABILITY

In grades K-4, the mathematics curriculum should include experiences with data analysis and probability so that students can:

- *collect, organize, and describe data;*
- *construct, read, and interpret displays of data;*
- *formulate and solve problems that involve collecting and analyzing data;*
- *explore concepts of chance.*

CCG Strand 6.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

The CCG and the Standards match consistently. Both documents have students explore games of chance. In addition, the CCG has students evaluate games in terms of fairness and make predictions about future outcomes. The CCG and Standards stress making, using and drawing conclusions from charts, graphs and tables.

STANDARD 12: FRACTIONS AND DECIMALS

In grades K-4, the mathematics curriculum should include fractions and decimals so that students can:

- *develop concepts of fractions, mixed number, and decimals;*
- *develop number sense for fractions and decimals;*
- *use models to relate fractions to decimals and to find equivalent fractions;*
- *use models to explore operations on fractions and decimals;*
- *apply fractions and decimals in problem situations.*

CCG Strand within 1.0 and 2.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

This standard does not have a corresponding strand in the CCG. The fraction and decimal goals are found within the Number and Numeration Strand and the Computation Strand.

The CCG stresses the importance of modeling while using concrete and pictorial objects to develop concepts of fractions and decimals. This concrete knowledge base provides a better opportunity for developing number sense in fractions and decimals and in the operations using them.

Relating fractions to decimals is not directly stated in the CCG until conversion begins at the 8th grade level. In the CCG, decimal concepts are taught more from a place value model than from a fraction model.

The CCG orders, compares, and models fractions but does not specifically ask students to find equivalent fractions, although this is implied. Upon revision, the CCG should include goals concerning equivalency and the conversion of fractions to decimals in order to more closely align with the Standards and conform to the infusion of calculators into the curriculum.

STANDARD 13: PATTERNS AND RELATIONSHIPS

In grades K-4, the mathematics curriculum should include patterns and relationships so that students can:

- *recognize, extend, describe, and create a wide variety of patterns;*
- *represent and describe mathematical relationships;*
- *explore the use of variables and open sentences to express relationships.*

CCG Strand (all)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

The two documents agree in the importance of this standard. The CCG elaborates about how and where finding patterns and relationships need to be taught. These goals contain many connections to all the strands in the document.

Students are asked to sort and classify, find, create and extend patterns, as well as to explain mathematical relationships using the symbols >, <, and =.

STANDARD 1: MATHEMATICS AS PROBLEM SOLVING

In grades 5-8, the mathematics curriculum should include numerous and varied experiences with problem solving as a method of inquiry and application so that students can:

- *use problem-solving approaches to investigate and understand mathematical content;*
- *formulate problems from situations within and outside mathematics;*
- *develop and apply a variety of strategies to solve problems, with emphasis on multi-step and nonroutine problems;*
- *verify and interpret results with respect to the original problem situation;*
- *generalize solutions and strategies to new problem situations;*
- *acquire confidence in using mathematics meaningfully.*

CCG Strand 3.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both the Standards and the CCG suggest that the focus for the entire mathematics curriculum should be problem-solving instruction.

The Problem-solving Strand within the CCG matches the Problem-solving Standard by placing emphasis on using an approach to investigate and understand mathematics content and to develop a variety of strategies to solve problems. In particular, the CCG emphasizes solving problems by using a variety of problem-solving strategies, such as guess and check, look for a pattern, make a systematic list, and make a drawing.

In the CCG, students are asked to use a variety of sources and appropriate questioning strategies to formulate plans for solving a problem. They are also asked to discuss successful and unsuccessful strategies. They are encouraged to engage in cooperative problem solving with others while comparing alternative strategies. These last few statements within the CCG are a much stronger statement than is found in the Standards.

STANDARD 2: MATHEMATICS AS COMMUNICATION

In grades 5-8, the study of mathematics curriculum should include opportunities to communicate so that students can:

- *model situations using oral, written, concrete, pictorial, graphical, and algebraic methods;*
- *reflect upon and clarify their own thinking about mathematical ideas and situations;*
- *develop common understandings of mathematical ideas, including the role of definitions;*

- *use the skills of reading, listening, and viewing to interpret and evaluate mathematical ideas;*
- *discuss mathematical ideas and make conjectures and convincing arguments;*
- *appreciate the value of mathematical notation and its role in the development of mathematical ideas.*

CCG Strand 8.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents emphasize communication in all forms--speaking, writing, listening and reading--as being tremendously important in the study of mathematics.

The CCG emphasizes using vocabulary, speech, numerals and other symbol systems essential for effective problem solving and for effective oral and written communication about mathematical concepts and ideas. Likewise, the Standards document emphasizes modeling problem-solving situations using oral, written, concrete, pictorial, graphical, and algebraic methods.

The recognition that language arts skills are needed for the effective learning of mathematics is a strong part of both documents. Students need to be able to read mathematics, to write and/or talk about their learning and solutions processes, and to listen to others for confirming or reconsidering viewpoints. As stated in the CCG, "If we do not demand reading and writing in the mathematics classroom we will be preparing students to do mathematics, but not to be mathematically literate for the real-world in which mathematics is applied."

STANDARD 3: MATHEMATICS AS REASONING

In grades 5-8, reasoning shall permeate the mathematics curriculum so that students can:
- *recognize and apply deductive and inductive reasoning;*
- *understand and apply reasoning processes, with special attention to spatial reasoning and reasoning with proportions and graphs;*
- *make and evaluate mathematical conjectures and arguments;*
- *validate their own thinking;*
- *appreciate the pervasive use and power of reasoning as a part of mathematics.*

CCG Strand Within 7.0 & all Strands

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents state that reasoning or logical thinking should permeate the mathematics curriculum.

The Standards document chooses to stress reasoning by designating it as a separate standard while the CCG infuses reasoning throughout all the strands. Students are asked to reason by finding alternative ways to

determine an answer rather than use a formula. They are asked to relate new information to previous knowledge, to provide logical answers based upon factual data, and to use multiple sources to verify information.

Both documents suggest that students need to think mathematically which implies doing mathematics. Therefore, mathematics must be an active, dynamic undertaking.

STANDARD 4: MATHEMATICAL CONNECTIONS

In grades 5-8, the mathematics curriculum should include investigation of mathematical connections so that students can:

- *see mathematics as an integrated whole;*
- *explore problems and describe results using graphical, numerical, physical, algebraic and verbal mathematical models or representations;*
- *use a mathematical idea to further their understanding of other mathematical ideas;*
- *apply mathematical thinking and modeling to solve problems that arise in other disciplines, such as art, music, psychology, science, and business;*
- *value the role of mathematics in our culture and society.*

CCG Strand within 2.0, 7.0 and all Strands

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor. *

The Standards document emphasizes the connections within mathematics by demonstrating that different topics in mathematics can be related together and not thought of as separate entities.

Although both documents list many of the same topics, the CCG does little to tie the strands together. For example, the geometry/measurement topic for area can be used to examine multiplication, fractions or probability. These connections are missing within the CCG.

Because these connections are weak within the CCG, the first revision of the CCG should place emphasis on linking the various strands of mathematics.

STANDARD 5: NUMBER AND NUMBER RELATIONSHIPS

In grades 5-8, the mathematics curriculum should include the continued development of number and number relationships so that students can:

- *understand, represent, and use numbers in a variety of equivalent forms (integer, fraction, decimal, percent, exponential, and scientific notation) in real-world and mathematical problem situations;*
- *develop number sense for whole numbers, fractions, decimals, integers, and rational numbers;*
- *understand and apply ratios, proportions, and percents in a wide variety of situations;*
- *investigate relationships among fractions, decimals, and percents;*
- *represent numerical relationships in one- and two-dimensional graphs.*

CCG Strand 1.0, 2.0, 7.0 and all Strands

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

Both documents emphasize an understanding of numbers through experiences with manipulatives. Development of a strong number sense is important.

Both documents stress relationships between different number sets like fractions, decimals and percents, but in the CCG emphasis is more informal and conceptual in nature.

STANDARD 6: NUMBER SYSTEMS AND NUMBER THEORY

In grades 5-8, the mathematics curriculum should include the study of number systems and number theory so that students can:

- ***understand and appreciate the need for numbers beyond the whole numbers;***
- ***develop and use order relations for whole numbers, fractions, decimals, integers, and rational numbers;***
- ***extend their understanding of whole number operations to fractions, decimals, integers and rational numbers;***
- ***understand how the basic arithmetic operations are related to one another;***
- ***develop and apply number theory concepts (such a primes, factors, and multiples) in real-world and mathematical problem situations.***

CCG Strand 1.0 and 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

The CCG combines this standard and the previous one into a strand called Number and Numeration. Taken together the CCG has a better than adequate match with the two standards. Taken individually the match is just good. Both documents stress relationships between various number sets, such as >, <, =, and sequencing.

The CCG emphasizes an understanding of how the operations with whole numbers extend to fractions, decimals, percents and integers. As stated before, the CCG emphasizes the use of manipulative materials to develop this understanding.

The Standards document stresses an understanding of connections between the basic arithmetic operations. This emphasis is not present in the CCG and serves as another example of the minimal amount of linkage found in the CCG.

STANDARD 7: COMPUTATION AND ESTIMATION

In grades 5-8, the mathematics curriculum should include development of the concepts underlying computation and estimation in various contexts so that students can;

- *compute with whole numbers, fractions, decimals, integers, and rational numbers;*
- *develop, analyze, and explain procedures for computation and techniques for estimation;*
- *develop, analyze, and explain methods for solving proportions;*
- *select and use an appropriate method for computing from among mental arithmetic, paper and pencil, calculator, and computer methods;*
- *use computation, estimation, and proportions to solve problems;*
- *use estimation to check the reasonableness of results.*

CCG Strand 2.0, also 5.0 and 6.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents stress the need for using the basic operations of arithmetic on various number sets. As shown above, the Standards document also emphasizes estimation.

The CCG infuses estimation throughout the document. Estimation is performed with the operations of add, subtract, multiply and divide and also while doing such applications as perimeter, area, volume, statistical situations, probability situations, etc.

Both documents do an excellent job of having students consider the most appropriate method for computing, whether it be mental, manipulative, paper and pencil, calculator or computer.

STANDARD 8: PATTERNS AND FUNCTIONS

In grades 5-8, the mathematics curriculum should include explorations of patterns and functions so the students can:

- *describe, extend, analyze, and create a wide variety of patterns;*
- *describe and represent relationships using tables, graphs, and rules;*
- *analyze functional relationships to explain how change in one quantity affects change in another;*
- *use patterns and functions to represent and solve problems.*

CCG Strand 6.0 and 7.0, also 1.0, 3.0, and 4.0, and across all Strands

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Since describing, extending, analyzing and creating patterns play such an important role in problem solving, it is not surprising to find a strong match between the two documents.

The pattern, relationship and function portions of the CCG fall within the Statistics and Probability Strand and also within the Mathematical Relationships Strand. Patterns are also found in most of the other strands. Students are asked to find both geometric, as well as numeric patterns and to be able to make predictions based upon that information.

The CCG is weak in developing the concept of function. This concept is a natural outgrowth of the pattern-extension notion and can be easily modeled through activities with manipulative materials.

STANDARD 9: ALGEBRA

In grades 5-8, the mathematics curriculum should include explorations of algebraic concepts and processes so that students can:

- ***understand the concepts of variable, expression, and equation;***
- ***represent situations and number patterns with tables, graphs, verbal rules, and equations, and explore the interrelationships of these representations;***
- ***analyze tables and graphs to identify properties and relationships;***
- ***develop confidence in solving linear equations using concrete, informal, and formal methods;***
- ***investigate inequalities and nonlinear equations informally;***
- ***apply algebraic methods to solve a variety of real-world and mathematical problems.***

CCG Strands included in 3.0, 4.0, 6.0, and 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is <u>fair</u>. **

To better understand the low correlation with this standard, an explanation of the <u>purpose of the CCG</u> is necessary. The intent of the CCG is to give guidelines for the <u>mathematics deemed necessary for ALL Oregon students</u>. The primary emphasis is on grades K-8. Since only some 8th grade students take algebra, the <u>CCG does not include an emphasis on algebra</u>.

This does not say that algebraic notions are not present within the CCG. The previously mentioned emphasis on problem solving, patterns and relationships is prerequisite to a strong algebra program. Activities using reasoning and logical thinking prepare students for an algebra course. The development of each of the various number sets including integers also provides students with a background for the study of algebra.

STANDARD 10: STATISTICS

In grades 5-8, the mathematics curriculum should include explorations of statistics in real-world situations so that students can:

- ***systematically collect, organize, and describe data;***
- ***construct, read, and interpret tables, charts, and graphs;***

- *make inferences and convincing arguments based on data analysis;*
- *evaluate arguments based on data analysis;*
- *develop an appreciation for statistical methods as powerful means for decision making.*

CCG Strand 6.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents have taken the position that students will be exposed to many, many statistics. Educators need to do everything possible to prepare students for utilizing statistics as a means of understanding the quantitative information presented and used in all careers.

The CCG include many instances in which students collect, organize, display, analyze and use data. Students are also asked to evaluate data and evidence. In addition, they need to recognize misleading or incorrect methods of displaying or interpreting data.

STANDARD 11: PROBABILITY

In grades 5-8, the mathematics curriculum should include explorations of probability in real-world situations so that students can:

- *model situations by devising and carrying out experiments or simulations to determine probabilities;*
- *model situations by constructing a sample space to determine probabilities;*
- *appreciate the power of using a probability model through comparison of experimental results with mathematical expectations;*
- *make predictions based on experimental or mathematical probabilities;*
- *develop an appreciation for the pervasive use of probability in the real world.*

CCG Strand 6.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is fair. **

Again, the CCG has combined two topics into one strand while the Standards document lists each separately. Taken together the Statistics and Probability Strand of the CCG gives an excellent match with the Standards document. But taken individually the match between the two documents is fair in the area of probability.

The CCG emphasizes only the common notions of probability, for instance, understanding the probability of an event and using that probability to predict future events. Students will use probabilities of 0 and 1.

But in the areas of modeling probability situations or in constructing sample spaces to reflect or determine a probability, the CCG is less comprehensive.

STANDARD 12: GEOMETRY

In grades 5-8, the mathematics curriculum should include the study of the geometry of one, two, and three dimensions in a variety of situations so that students can:

- *identify, describe, compare, and classify geometric figures;*
- *visualize and represent geometric figures with special attention to developing spatial sense;*
- *explore transformations of geometric figures;*
- *represent and solve problems using geometric models;*
- *understand and apply geometric properties and relationships;*
- *develop an appreciation of geometry as a means of describing the physical world.*

CCG Strand 4.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents recognize that we live in a geometric world and students need to see the connections between the real world and the mathematics they are learning in school.

The CCG emphasizes identifying, describing, comparing, classifying, visualizing and representing geometric figures in one-, two-, and three-dimensional forms. Students develop ways of finding answers to problems, (e.g., area) without relying on a formula.

Very little is found in the CCG on transformations or on using geometric properties to solve problems.

STANDARD 13: MEASUREMENT

In grades 5-8, the mathematics curriculum should include extensive concrete experiences using measurement so that students can:

- *extend their understanding of the process of measurement;*
- *estimate, make, and use measurements to describe and compare phenomena;*
- *select appropriate units and tools to measure to the level of accuracy required in a particular situation;*
- *understand the structure and use of systems of measurement;*
- *extend their understanding of the concepts of perimeter, area, volume, angle measure, capacity, and weight/mass;*
- *develop the concepts of rates and other derived and indirect measurements;*
- *develop formulas and procedures for determining measures to solve problems.*

CCG Strand 5.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

Both documents strive to develop an understanding of various types of measurements in metric and/or customary units. Estimation is a strong part of the process in both documents.

The CCG focuses on using an activity mode in which students experience various measurements. Locating map coordinates, making scale drawings, and indirectly finding distances are emphasized in the upper grades.

Discovering and expressing formulas is approached in an informal, developmental way as students explore alternative ways to determine the measurement of an object.

GRADES 9-12

INTRODUCTION

As one reads the following comparison of the Oregon Comprehensive Curriculum Goals and the NCTM Standards for grades 9-12, it is important to be aware of a significant difference in the scope of the two documents. The NCTM Standards addresses all levels of mathematics taught in grades 9-12, including those courses designed for college-intending students. The CCG, on the other hand, includes recommendations only for courses which would satisfy Oregon's two-year graduation requirement in mathematics for all students. The CCG writing team considered only that content which did not require algebra or advanced courses for inclusion in its recommendations.

Other differences which are related to scope also exist between the two documents. NCTM Standards recommend at least three years of mathematics for all students and four years for college-intending students. It is further recommended that all students be enrolled in a mathematics course in grade 12. The CCG, on the other hand, was written under the guidelines that all students should take a minimum of two years of mathematics while college-intending students take at least three years.

A final difference is the strong recommendation contained in the NCTM Standards which calls for all students to be exposed to a "common core" of mathematical content. This content is significantly beyond what is now expected in most secondary schools in the United States. A discussion of the "common core" can be found on pages 123-124 of the NCTM Standards.

STANDARD 1: MATHEMATICS AS PROBLEM SOLVING

In grades 9-12, the mathematics curriculum should include the refinement and extension of methods of mathematical problem solving so that all students can:

- *use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content;*
- *apply integrated mathematical problem-solving strategies to solve problems from within and outside of mathematics;*
- *recognize and formulate problems from situations within and outside of mathematics;*
- *apply the process of mathematical modeling to real-world problem situations.*

CCG Strand 3.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

With regard to problem solving, the two documents closely agree in both emphasis and philosophy. The CCG identifies problem solving as a content strand and also as an instructional theme while the NCTM Standards includes problem solving as a standard at all grade levels.

The CCG defines problem solving as the process of using one's knowledge and experience when encountering new and unexpected situations. Teachers are asked to provide a non-threatening atmosphere in which students can use a variety of strategies and approaches to solve problems. Problems should come from both "real-world" situations and mathematical contexts. Students are asked to define the problem, seek additional information, design, and carry out a strategy for finding a solution using specific skills such as guess and check, look for a pattern or make a drawing. In addition, a strong emphasis is placed on having students discuss and evaluate alternative strategies in large and small group settings.

The Standards document suggests that by grade 9, students should find that the individual problem-solving skills experienced in earlier grades will blend into strategies which allow more holistic approaches to problem solving.

STANDARD 2: MATHEMATICS AS COMMUNICATION

In grades 9-12, the mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas so that all students can:

- *reflect upon and clarify their thinking about mathematical ideas and relationships;*
- *formulate mathematical definitions and express generalizations (potential theorems) discovered through investigations;*
- *express mathematical ideas orally and in writing;*
- *read written presentations of mathematics with understanding;*
- *ask clarifying and extending questions related to mathematics they have read or heard about;*
- *appreciate the power, elegance, and economy of mathematical notation and its role in the development of mathematical ideas.*

CCG Strand 8.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is excellent. ****

The NCTM Standards and the CCG take parallel approaches in calling for a much greater emphasis on the use of communication skills in mathematics. They both call for students to read mathematics and interpret mathematical vocabulary, symbols, graphs, and charts. Students are also asked to use written and oral communication to brainstorm ideas, form generalizations and conjectures, and present supporting arguments.

The CCG includes oral and written communication as a content strand and also identifies cooperative learning as an instructional theme. In addition, a major requirement within both the Problem-solving Strand and instructional theme is that students communicate strategies used when solving problems.

STANDARD 3: MATHEMATICS AS REASONING

In grades 9-12, the mathematics curriculum should include numerous and varied experiences that reinforce and extend logical reasoning skills so that all students can:

- *make and test conjectures;*
- *formulate counter examples;*
- *follow logical arguments;*
- *judge the validity of arguments;*
- *construct simple valid arguments;*

and so that, in addition, college-intending students can:

- *construct proofs for mathematical assertions, including indirect proofs and proofs by mathematical induction.*

CCG Strand 6.0 and 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

While the CCG does not dedicate an entire content strand to reasoning, it does incorporate many of the requirements put forth in this standard. For example, within the Mathematical Relationships and/or Statistics and Probability Strands, students are asked to sort and classify, use logical thinking, and to develop, test and analyze hypotheses. They are also expected to use evidence from verifiable sources to support their own conclusions and to distinguish between logical and illogical conclusions by others.

The CCG does not address using counter examples, indirect proofs or proofs by mathematical induction. It should be noted that proof is a topic normally covered in classes for college-intending students, such as formal geometry, and which were not addressed by the CCG.

STANDARD 4: MATHEMATICAL CONNECTIONS

In grades 9-12, the mathematics curriculum should include investigation of the connections and interplay among various mathematical topics and their application so that all students can:

- *recognize equivalent representations of the same concept;*
- *relate procedures in one representation to procedures in an equivalent representation;*
- *utilize and value the connections among mathematical topics;*
- *utilize and value the connections between mathematics and other disciplines.*

CCG Strand 2.0 and 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

The CCG strongly argues for using manipulatives and "real-world" settings which are familiar to students when introducing abstract mathematical concepts. It also advocates the "unified" or "integrated" organizational approach for secondary mathematics programs which encourages connections between topics normally covered in traditional algebra and geometry courses. The NCTM Standards goes beyond connections between topics in algebra and geometry to the point of calling for connections to be made between topics in all areas of mathematics.

In the area of connections between mathematics and other disciplines, the CCG calls for substantial integration of reading and writing skills into the mathematics curriculum. Beyond the language arts area and the implied connections with science and social studies, few connections are included with regard to integration with other disciplines.

STANDARD 5: ALGEBRA

In grades 9-12, the mathematics curriculum should include the continued study of algebraic concepts and methods so that all students can:

- *represent situations that involve variable quantities with expressions, equations, inequalities, and matrices;*
- *use tables and graphs as tools to interpret expressions, equations, and inequalities;*
- *operate on expressions and matrices, and solve equations and inequalities;*
- *appreciate the power of mathematical abstraction and symbolism;*

and so that, in addition, college-intending students can:

- *use matrices to solve linear systems;*
- *demonstrate technical facility with algebraic transformation, including techniques based on the theory of equations.*

CCG Strand 3.0, 4.0, 6.0, and 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is <u>poor</u>.

Due to the intended scope, the CCG does not extend through algebra. It does call for students to represent mathematical relationships in a variety of formats, such as maps, tables, charts, graphs and computer spreadsheets.

STANDARD 6: FUNCTIONS

In grades 9-12, the mathematics curriculum should include the continued study of functions so that all students can:

- *model real-world phenomena with a variety of functions;*
- *represent and analyze relationships using tables, rules, and graphs;*
- *translate among tabular, symbolic, and graphical representations of functions;*

- *recognize that a variety of problem situations can be modeled by the same type of function;*
- *analyze the effects of parameter changes on the graphs of functions;*

and so that, in addition, college-intending students can:

- *understand operations on, and the general properties and behavior of, classes of functions.*

CCG Strand 7.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor. *

As was the case with algebra, the CCG does very little in the way of addressing functions. Students are asked only to make tables and graphs for two-variable formulas.

STANDARD 7: GEOMETRY FROM A SYNTHETIC PERSPECTIVE

In grades 9-12, the mathematics curriculum should include the continued study of the geometry of two and three dimensions so that all students can:

- *interpret and draw three-dimensional objects;*
- *represent problem situations with geometric models and apply properties of figures;*
- *classify figures in terms of congruence and similarity and apply these relationships;*
- *deduce properties of, and relationships between, figures from given assumptions;*

and so that, in addition, college-intending students can:

- *develop an understanding of an axiomatic system through investigating and comparing various geometries.*

CCG Strand 4.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

Both documents emphasize a more intuitive, informal approach to geometry than is currently found in most secondary geometry classes. The CCG stresses the importance of students developing visualization skills by drawing three-dimensional objects and by drawing cross-sections of various solids. Students are also asked to classify two- and three-dimensional geometric shapes and solids according to attributes and properties including symmetry, congruency and similarity. In addition, students are expected to apply their understanding of the properties of geometric figures when solving problems.

The CCG stresses a measurement component in geometry and its application. The NCTM Standards tends to ignore measurement at this level. Another difference in the two documents is that the CCG, while recognizing the value of computers and their application in geometry, falls short of the NCTM Standards in the area of calculator or computer-based explorations of two- and three-dimensional figures. Also, the expectation that college-intending students should investigate various non-Euclidean geometries, such as eliptic, hyperbolic, etc., is found in the NCTM Standards but not included in the CCG.

STANDARD 8: GEOMETRY FROM AN ALGEBRAIC PERSPECTIVE

In grades 9-12, the mathematics curriculum should include the study of the geometry of two and three dimensions from an algebraic point of view so that all students can:

- *translate between synthetic and coordinate representations;*
- *deduce properties of figures using transformations and rising coordinates;*
- *identify congruent and similar figures using transformations;*
- *analyze properties of Euclidean transformations and relate translations to vectors;*

and so that, in addition, college-intending students can:

- *deduce properties of figures using vectors;*
- *apply transformations, coordinates, and vectors in problem solving.*

CCG Strand (none)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor.

The CCG does not address this standard.

STANDARD 9: TRIGONOMETRY

In grades 9-12, the mathematics curriculum should include the study of trigonometry so that all students can:

- *apply trigonometry to problem situations involving triangles;*
- *explore periodic real-world phenomena using the sine and cosine functions;*

and so that, in addition, college-intending students can:

- *understand the connection between trigonometric and circular functions;*
- *use circular functions to model periodic real-world phenomena;*
- *apply general graphing techniques to trigonometric functions;*
- *solve trigonometric equations and verify trigonometric identities;*
- *understand the connections between trigonometric functions and polar coordinates, complex numbers, and series.*

CCG Strand (none)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor. *

The Oregon CCG does not address this standard.

STANDARD 10: STATISTICS

In grades 9-12, the mathematics curriculum should include the continued study of data analysis and statistics so that all students can:

- *construct and draw inferences from charts, tables, and graphs that summarize data from real-world situations;*
- *use curve-fitting to predict from data;*
- *understand and apply measures of central tendency, variability, and correlation;*
- *understand sampling and recognize its role in statistical claims;*
- *design a statistical experiment to study a problem, conduct the experiment, and interpret and communicate the outcomes;*
- *analyze the effects of data transformations on measures of central tendency and variability;*

and so that, in addition, college-intending students can:

- *transform data to aid in data interpretation and prediction;*
- *test hypotheses using appropriate statistics.*

CCG Strand 6.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is good. ***

The corresponding content strand in the CCG, Statistics and Probability, is in close alignment with the NCTM Standards. There is a strong emphasis on having students gather, arrange, and display data in charts, tables and graphs and then to make appropriate predictions. Students are also asked to identify incorrect and misleading methods of displaying and interpreting data.

Communication, both written and oral, plays an important role in the expectations found in both the CCG and the Standards. They call for students to discuss and analyze interpretations, report their findings, and defend their conclusions.

The CCG asks students to find and use measures of central tendency (i.e., mean, median, mode), range, and percentile, but does not include measures of variation and correlation as are found in the Standards.

STANDARD 11: PROBABILITY

In grades 9-12, the mathematics curriculum should include the continued study of probability so that all students can:

- *use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty;*
- *use simulations to estimate probabilities;*
- *understand the concept of random variable;*
- *create and interpret discrete probability distributions;*
- *describe, in general terms, the normal curve and use its properties to answer questions about sets of data that are assumed to be normally distributed;*

and so that, in addition, college-intending students can:

- *apply the concept of random variable to generate and interpret probability distributions including binomial, uniform, normal, and chi-square.*

CCG Strand 6.0

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor.*

The approach of the CCG to probability is to expect students to gain an intuitive understanding of probability. The NCTM Standards goes substantially further.

STANDARD 12: DISCRETE MATHEMATICS

In grades 9-12, the mathematics curriculum should include topics from discrete mathematics so that all students can:

- *represent problem situations using discrete structures, such as finite graphs, matrices, sequences, and recurrence relations;*
- *represent and analyze finite graphs using matrices;*
- *develop and analyze algorithms;*
- *solve enumeration and finite probability problems;*

and so that, in addition, college-intending students can:

- *represent and solve problems using linear programming and different equations;*
- *investigate problem situations that arise in connection with computer validation and application of algorithms.*

CCG Strand (none)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor.*

The CCG does not address Discrete Mathematics.

STANDARD 13: CONCEPTUAL UNDERPINNINGS OF CALCULUS

In grades 9-12, the mathematics curriculum should include the informal exploration of calculus concepts from both a graphical and numerical perspective so that all students can:

- *determine maximum and minimum points of a graph and interpret the results in problem situations;*
- *investigate limiting processes by examining infinite sequences and series and areas under curves;*

and so that, in addition, college-intending students can:

- *understand the conceptual foundations of limit, area under a curve, rate of change, and slope of a tangent line, and their applications in other disciplines;*
- *analyze the graphs of polynomial, rational, radical, and transcendental functions.*

CCG Strand (none)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor. *

The CCG does not address this standard.

STANDARD 14: MATHEMATICAL STRUCTURE

In grades 9-12, the mathematics curriculum should include the study of mathematical structure so that all students can:

- *compare and contrast the real number system and its various subsystems in terms of structural characteristics;*
- *understand the logic of algebraic procedures;*
- *appreciate that seemingly different mathematical systems may be essentially the same;*

and so that, in addition, college-intending students can:

- *develop the complex number system and demonstrate facility with its operations;*
- *prove elementary theorems within various mathematical structures, such as groups and fields;*
- *develop an understanding of the nature and purpose of axiomatic systems.*

CCG Strand (none)

The match between the Oregon Comprehensive Curriculum Goals (CCG) and the NCTM Standards for this standard is poor. *

The CCG does not address mathematical structure.

GRADES 9-12

CONCLUSION

At first glance, it may appear that the Oregon Comprehensive Curriculum Goals does not match well with the NCTM Standards. Most of the variation, however, can be attributed to a difference in scope which is described in the introduction to this section (See page 21).

The two documents are actually very similar in philosophy. They both make a strong case for learning mathematics actively through "doing" mathematics. Students need to experiment, generalize, form hypotheses, and defend conclusions. This calls for teaching practices different from the traditional lecture/discussion approach which results in passive learning modes for students. As we shift from a skill-based curriculum to one built around conceptual understanding and applications, teachers need to become coaches and facilitators. A variety of teaching strategies including the use of cooperative learning groups in which students learn to communicate about and with mathematics must be used. Both documents are very consistent in their recommendations in relation to learning and instruction.

In conclusion, the Oregon Comprehensive Curriculum Goals and the NCTM Standards used together, should provide excellent guidance for school districts in Oregon when evaluating or revising mathematics curriculum for grades 9-12 as well as for grades K-12.

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